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Isotoma blekeni n. sp. (Collembola : Isotomidae) from coniferous forest in Norway Ecological segregation ofrelated, coexisting species

BY

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INTRODUCTION

The *Isotoma violacea* complex of northern Europe has been revised by FJELLBERG (1976 & 1979). He shows that the *mucronata* form of *Isotoma hiemalis* Schøtt has been confused with *Isotoma violacea* Tullberg. The two species are maintained, but are distinguished on other criteria than mentioned by GISIN (1960). During my investigation on Collembola communities in coniferous forests, it has become clear that a third species within this complex is quite common: *Isotoma blekeni* n. sp.

Type locality: Norway, Nordmoen at Romerike (UTM: 32 V PM 169 819).

Type material: Holotype: A specimen (in alcohol) labelled « Norway: Nordmoen, Romerike, forest field, in snow, 6/1 1979. H. P. LEINAAS leg. ». Deposited at Zoological Museum, Oslo.

Paratypes: Specimens collected in the same area as holotype, all deposited at Zoological Museum, Oslo. 50 in alcohol and 10 on slides, all collected 2/11 1977 at « clear cut area, S-stata, H. P. Leinaas leg. » and 20 in alcohol collected in « moss strata, 10/5 1979, E. Bleken leg. ».

The species is named after my student E. BLEKEN, who kindly let me use his material on the species.

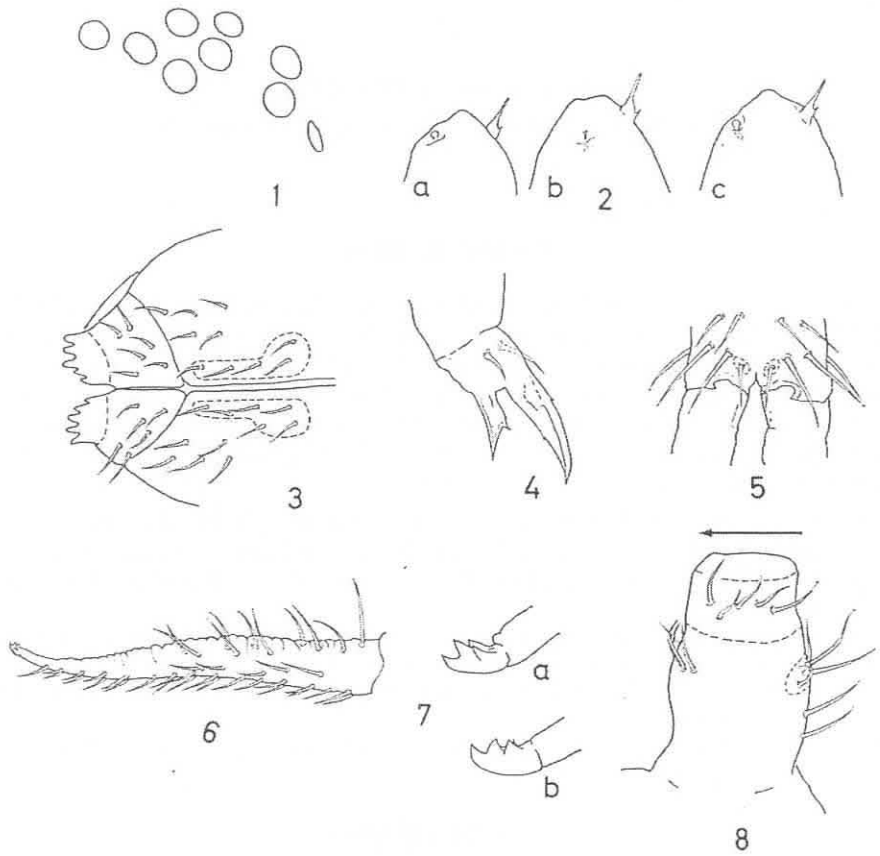
I. — DESCRIPTION

Colour: Dark violet blue, nearly black. Almost unpigmented on lateral and posterior part of head and on the legs and dens. Antennae red-violet, darkest on Ant. IV.

Reçu le 8-7-1979.

Head: 8 +8 ocelli. PAO small, elongated, 0.9 - 1.1. as long as the diameter of nearest ocellus (Fig. 1). The subapical sensillum of Ant. IV globular (summer) or a thin rod with the end swollen (winter) (cyclomorphosis). Pin seta with a short basal process (Fig. 2). Labrum with 4 sharp apical folds and a ventro-apical ciliation composed of several rows (brush). Maxillae with short lamellae. Along ventral line of head, 5 - 6, usually 6 setae (Fig. 3).

Body: Macrochaeta weakly serrated and moderately long. Those on Abd. V are 1.1 - 1.5 times as long as the dorsal length of the segment and 2.8 - 3.0 times as long as the inner length of claw III. Claws slender with small teeth, empodium with strong tooth (Fig. 4). Manubrium with sharp apical teeth and 1 + 1 apical short setae (Fig. 5). Dens with many crenulations and 9 - 11, usually 10 dorsal setae (Fig. 6). Mucro with four teeth, the apical large. Mucronal seta absent. Summer animals have somewhat more slender mucro than winter animals (Fig. 7). This cyclomorphosis is less conspicuous than in *I. hiemalis*. Ventral



Pl. I. — Figs. 1-8. *Isotoma blekeni* n. sp. — 1. Right PAO and eyes. — 2. Tip of Ant. IV, showing pin setae and sub apical sensillum, a) young specimen from Sep. - 77, b) « Winter form » Jan. - 79, c) Adult, May - 78. — 3. Setae along ventral line of head (encircled). — 4. Claw III. — 5. Apical part of manubrium, ventral. — 6. Dens and mucro. — 7. Mucro, a) « winter form » Nov. - 77, b) « summer form » May - 78. — 8. Right side of ventral tube (arrow points forward).

tube with 2 (2-4) frontal setae on each side of ventral line, 5-6 lateral and 6 (6-7) caudal setae of which 4 in the apical transverse row (Fig. 8). Tenaculum with 3 (2-4) setae and 4 + 4 teeth.

Size: Adults about 1 mm, largest specimen 1.3 mm.

Justification:

Isotoma blekeni is recognized by only about half the body size of its relatives. The general appearance resembles a small *I. violacea*: They have the same pigmentation, similar length of body macrochaeta and a more glossy appearance than *I. hiemalis* when seen alive. They also have weaker teeth on the claws than *I. hiemalis*. *Isotoma blekeni* resembles *I. hiemalis* in the composed row (brush) of ventro-apical ciliation of labrum, while *I. violacea* has a simple row (comb). The two former species also have PAO of similar size, although it is more elongated on *I. blekeni*. *Isotoma blekeni* differs from both species in the shape of pin setae of Ant. IV and in more sparse ciliation along the ventral line of the head and on the abdominal appendices. Table I shows some diagnostic characteristics of the three species in the *I. violacea* complex, based on Nordmoen populations.

II. — SCANNING ELECTRON MICROSCOPY STUDIES

The body macrochaeta of the species seem to be composed of filaments (Pl. II). *Isotoma blekeni* differs considerably from the others in the thickness and arrangement of the filaments. Smaller variations are seen between *I. hiemalis* and *I. violacea*.

Specific differences are seen on the cuticle of the three species (Pl. II). The less glossy appearance of *I. hiemalis* is probably due to the open structure of its cuticle, with large areas between the granules. Both *I. blekeni* and especially *I. violacea* have more dens structures. According to DALLAI (1977), Isotomidae have a rather constant pattern of more or less closely connected quadrangular granules. This is typically seen on *I. violacea*. The other two species shows some aberrations. *Isotoma blekeni* possess a less ordered pattern with significant variation in the size of the granules. On the cuticle of *I. hiemalis* both pentagonal and hexagonal rings are often seen. No other morphological characteristics considered in this study showed more distinct differences between all three species. Apparently cuticular structures may be useful in the taxonomy of *Isotoma*.

III. — DISTRIBUTION AND ECOLOGY

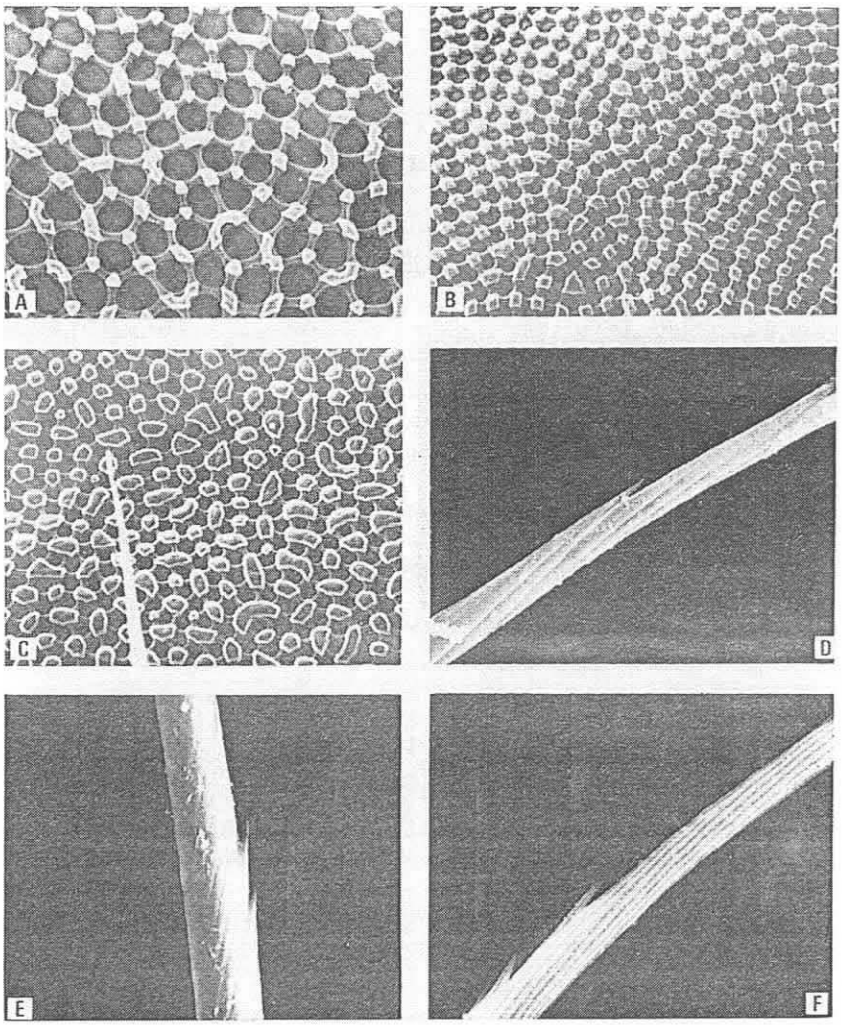
Isotoma blekeni appears to be common distributed in boreal forests in south east Norway. I have found it on all four areas where I have studied epedaphic Collembola. Apart from Nordmoen: Slørstad in Ås (UTM: 32V PM 014 178), Heikampen in Oslo (UTM: 32V NM 902 568), and Storetjern

TAB. I

Diagnostic characters of *Isotoma hiemalis, I. violacea* and *I. blekeni*. Adult specimens of populations from Nordmoen, eastern Norway

	Size	Pigment on legs	Length of macrocaeta on Abd. V	PAO/diam. of nearest ocellus	Shape of pin seta on Ant. IV	Ciliation :			Short apical seta on manubr.	Dorsal setae on dens.
						Alonghventral line of head	Ventral tube, lateral*	Tenac.		
I. hiemalis.....	2-2.5 mm	+	> 2X width of tergite	ca. 1	bifurcated	10-14	16-21	17-18	2+2/ 3+3	12-13
I. violacea.....	ca. 2 mm	—	< 2X width of tergite	1.3-1.5	bifurcated	9-12	16-21	8-11	2+2	14-16
I. blekeni.....	ca. 1 mm	—	< 2X width of tergite	ca. 1	short basal process	5-6	5-6	3-4	1+1	9-10

* The same specific differences are also found on the frontal and caudal ciliation.



PL. II. — Cuticular pattern of body tergites (A-C) and aspect of macrochaeta from Abd. V (D-F). (× 5.000). *Isotoma hiemalis* (A, D), *I. violacea* (B, E), *I. blekeni* (C, F).

in Åmot (UTM: 32V PP 537 015). In addition was it found on snow in coniferous forest at Skansebakken in Oslo (UTM: 32V NM 881 558).

Isotoma blekeni seems to be more restricted to coniferous forest than the other two species. *Isotoma violacea* has its main distribution in the alpine region, mostly in drier habitats, but I have also found it quite common in subalpine and lowland forests. *Isotoma hiemalis* is distributed in both deciduous and coniferous forests up to the timber line and is occasionally found in more humid alpine habitats. All three species coexist in the Nordmoen area. As expected, ecological segregation among closely related species was

observed. The area is flat with dry spruce forest of the Eu-Pinceetum association on transition towards mixed coniferous forest. The ground is mostly covered with blue-berry above the moss layer, but smaller areas with only moss vegetation are scattered about. These moss spots are assumed to be drier habitats due to good drainage (A. PEDERSEN pers. comm.). A stratified sampling was carried out based on these two forms of vegetation cover (E. BLEKEN unpubl.). Two blue-berry strata (B_I & B_{II}) and two moss strata (M_I & M_{II}) were designed, each of about 50 m^2. Sampling were performed 10 times from May 23 to November 4, collecting 3 soil cores of 10 cm diam. pr. strata each time.

Isotoma hiemalis occurred throughout the area, but were most numerous on the moss strata (Tab. II). *Isotoma violacea* on the other hand was not

TAB. II

Habitat preferences of coexisting populations of species in the *Isotoma violacea* group

A. Number of animals found by stratified sampling during a year
Each number is based on 30 soil samples

B. Number of animals found in 12 samples from needle litter
All samples were taken by a corer of 10 cm diameter

	A				B
	Blueberry strata		Moss strata		Needle litter
	I	II	I	II	
I. hiemalis.....	4	35	80	57	5
I. violacea.....					41
I. blekeni.....			16	241	

found on any of the strata, but occurred commonly on specific spots where needle litter formed thick layers at the base of some trees. Thus, *I. violacea* seems to be restricted to special microhabitats in the forest floor, probably in requirement for dry places. *Isotoma blekeni* showed an intermediate position in distribution pattern. It was only found in the moss strata, mostly in M_{II}. In contrast was *I. hiemalis* found in highest number (although not significant) in M_I.

In another study field at Nordmoen, the effect of clear cutting on the Collembola have been studied. Part of an uniform area was deforested in April 1972. The rest of the area was left undisturbed as a control. Soil samples were collected from the control area, from places where all kind of logging litter had been removed immediately after logging (S-stratum) and from areas with logging litter (K-stratum). *Isotoma blekeni* showed a significant increase on the clear cut area, notably on the S-stratum, compared to the control (Tab. III). The effect occurred already the first summer and was still seen

in 1977. Presumably it is a positive reaction related to the change to drier microclimate which was most pronounced on the S-stratum. A preference for relatively dry habitats by *I. blekeni* is in agreement with the other finds mentioned.

TAB. III

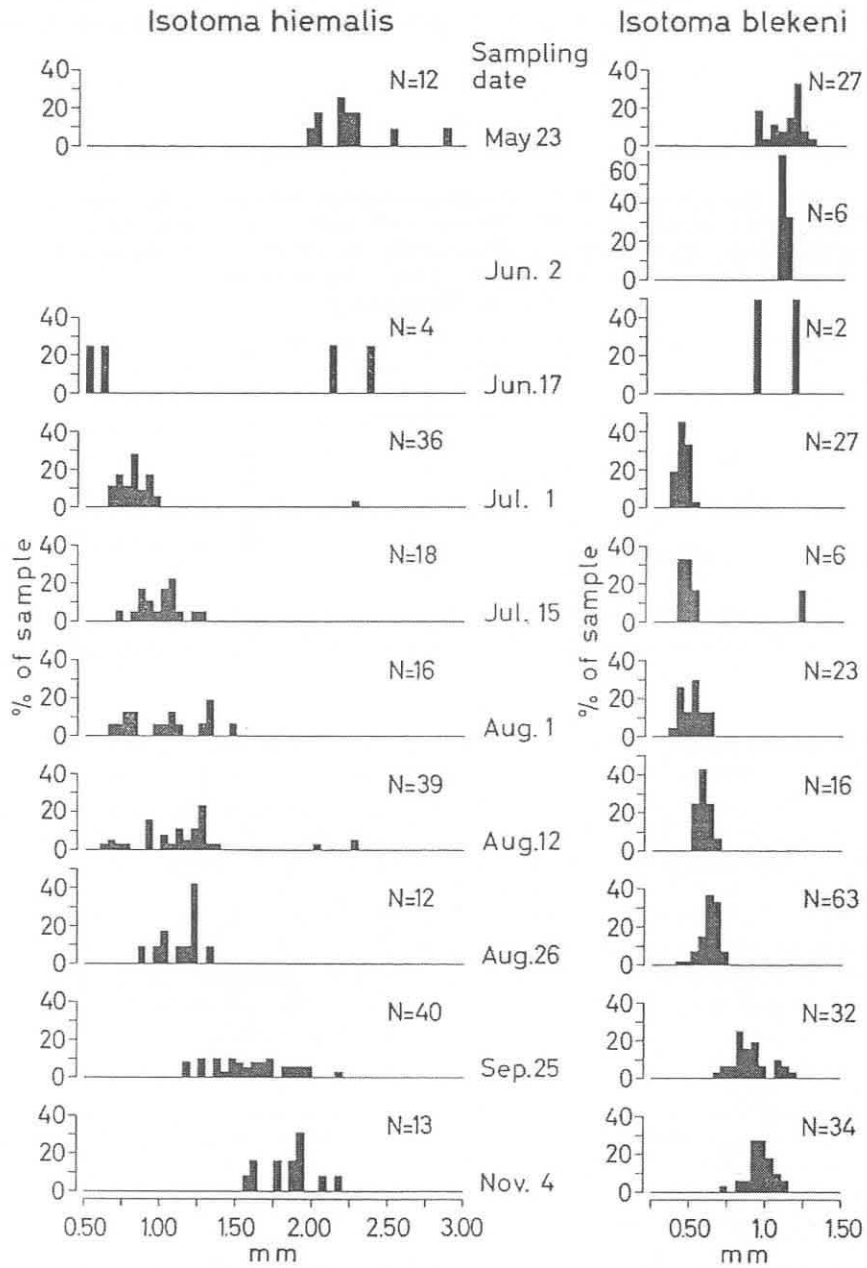
Isotoma hiemalis and *I. blekeni* collected from two strata on a clear cut area and from a control forest stand. The 1972 materials refers to 5 sampling dates from July to November. Each number is based on 100 soil samples of 36 mm diameter. The 1977 material is based on 10 soil samples of 100 mm diam. from each strata, collected November 2

		Control forest	K-stratum of clear cut area	S-stratum of clear cut area
1972	*I. hiemalis*.....	2	8	1
	I. blekeni.....	4	22	105
1977	*I. hiemalis*.....	3		
	I. blekeni.....		7	84

Difference in the cuticular structure is seen in connection with ecological differences between the species. The cuticular structure is of importance for the resistance against desiccation. In lack of tracheal systems, gas exchanges take place through the body surface, which makes the animals sensitive to drought. Hydrofuge wax coating is mostly restricted to the granules. The rest of the cuticle is permeable to both oxygen and water (NOBLE-NESBITT, 1963 a, b). *Isotoma hiemalis* has its main distribution in humid habitats, and have cuticle offering less protection against desiccation. The other two species are much better endowed with « water proof » granules. As *I. violacea* is twice as large as *I. blekeni* it is less exposed to desiccation. This agrees with *I. violacea* having highest preference for dry habitats.

All three species have similar life history. They overwinter as full-grown individuals, becoming sexually mature and laying eggs in the spring. They soon started egglaying when placed in culture chambers in May. In the field the new generations hatched in the last part of June. Plate III indicates the life history of *I. hiemalis* and *I. blekeni* according to variations in the body size of the populations during a year.

The smaller size of *I. blekeni* and the microecological segregation of these species reduces competition. Therefore, there is little selection for differences in reproductive periodisms, which otherwise might be expected in closely related, coexisting species (e.g. *Isotoma olivacea* and *I. infuscata* (FJELLBERG, 1979).



PL. III. — Body size structure of *Isotoma hiemalis* and *I. blekeni*. Populations from Nordmoen, eastern Norway.

Summary

Isotoma blekeni n. sp. is described from coniferous forest in Norway. It is closely related to *I. violacea* and *I. hiemalis*. All three species occurred in the same area, and showed similar life cycles. However, marked differences were observed in their choice of microhabitat. Differences in the cuticular structure between the species reflects varying degrees of exposure to drought in their respective microhabitats.

Résumé

Isotoma blekeni n. sp., décrite d'une forêt de conifères de Norvège, est affine de *I. violacea* et de *I. hiemalis*. Ces trois espèces ont été récoltées dans la même aire et leurs cycles vitaux sont semblables. Cependant, des différences marquées ont été observées en ce qui concerne leur micro-habitat. Des différences de structure de la cuticule entre les espèces sont à mettre en rapport avec un gradient d'aridité croissant dans leurs micro-habitats respectifs.

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